SEMP Ecosystem Characterization and Monitoring (ECMI)
Annual Report
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Introduction

Brief Background on Project

Within the SEMP, the Ecosystem Characterization and Monitoring Initiative (ECMI) was established to design, develop, and demonstrate an ecosystem characterization and monitoring concept appropriate for military installations. The ECMI products must support multiple SEMP objectives and be beneficial to installation land managers. The ECMI baseline monitoring concepts are intended to have broad applicability and may serve as a model for other installations.

Objective of Project

The objective of ECMI is to develop a framework to characterize the long-term spatial and temporal dynamics of key ecosystem properties and processes in a way that is jointly beneficial to ecosystem research activities and military land management operations. The monitoring conducted under the ECMI is expected to produce a multi-purpose, integrated, baseline ecological information base. This ECMI information base will:

1) support SEMP ecological research related to sustainable management of DOD lands,
2) contribute baseline level data to the integrated monitoring plan of the host site,
3) establish a long-term ecological data set at the host site that will, over time, allow the assessment of relationships between land use, management and ecosystem sustainability, and
4) be compatible with monitoring data sets collected by other agencies in the region.

Approach

The approach has been to complete the design and implementation phase (Phase I, 1999-2001) as described in "Long-Term Monitoring Program, Fort Benning, GA (see Kress 2001). Some adjustments have been made to the original design, in particular to the surface water component because of the extended drought being experience in the Fort Benning region. The ECMI product is now ready to enter the modification phase (Phase II, 2002-2005).

Summary of Monitoring Activities and Results for FY01 (October 1, 2000 thru September 30, 2001)

Meteorology

Meteorology parameters have been monitored at 10 sites since FY99. The data and summary statistics from 1999 through July 2001 are on the SEMP data repository. The ECMI team worked with personnel in the land management branch at Fort Benning to provide them with the software and training necessary to enable them to download the meteorology data directly, on a twice daily basis for their in-house needs.

Surface Water

The surface water component was re-designed and re-implement during summer 2001 to accommodate the current drought trend and subsequent low stream flows. We are now monitoring water flow, level and temperature only with automated stations. Water quality parameters are being monitored at six sites via manual sampling on a bi-weekly basis. When the precipitation pattern trends toward a wetter period and stream flows are more robust we will

consider deployment of fully automated systems. A technical report has been published describing the procedure used to delineate the streams and develop the watershed boundaries on Fort Benning (Graves 2001).

Ground Water

The ground water monitoring system was fully implemented at four sites during spring and summer 2001. Ground water data are being collected hourly and entered onto the repository on a monthly basis.

Aquatic

The aquatic monitoring procedure was fully implemented during 2000 and the first re-sampling was completed in June 2001. Initial characterization and monitoring results will be placed on the repository 1QTR FY02. A summary of the preliminary results is described below under findings and conclusions.

Land Cover

A land cover map (using 1999 LandSAT ETM data) with accuracy assessment was developed during FY01 and placed on the repository. Pattern analysis of land cover, using fragmentation statistical procedures, was completed during 4QTR FY01. These data will be placed on the repository during 1QTR FY02. The team is also in the process of working with Virginia Dale and Lisa Olsen of Oak Ridge Laboratory to compare procedures and lessons learned in developing land cover maps of Fort Benning. They are developing a tool and procedure to develop land cover maps using a series of imagery, photos, and other land cover information from 1999 and previous dates (e.g. an historical time series) and the ECMI team will be developing a series of land cover maps with imagery from 1999 into the future. Our intent is to provide a quality land cover map and procedure that best supports the research groups and Fort Benning personnel. A technical note has been published describing the procedure and the results of the land cover map and accuracy assessment (see Bourne 2001).

Erosion and Deposition

The erosion/deposition component was fully implemented during FY01 and the first re-sampling occurred in early October 2001. The characterization data has been placed on the repository and the re-sampling results will be placed on the repository during 1QTR FY02. The ECMI team is working with Lawson Smith of Tony Krzysik's team to ensure that the ECMI method (watershed and installation scale monitoring) supports their research effort to characterize specific small-scale erosion processes. The idea is to link the two efforts so that the results of their research can provide a more complete picture of the small to large-scale erosion processes occurring on Fort Benning. A technical note and a technical report have been published based on the efforts to develop the erosion/deposition component. The technical note describes the development of the high precision horizontal and vertical ground control network set up on Fort Benning. This network is available to anyone needing accurate x, y, and z coordinates on Fort Benning (Hahn 2001). A letter report describes the field test of the S-tracker system that is used to characterize and monitor micro-topography profiles on the ECMI erosion monitoring sites. The technical report describes the initial characterization of the ECMI erosion/deposition monitoring sites using the S-tracker system (Hahn, Graves and Price 2001).

Woody Productivity

The woody productivity component was implemented during FY01 in cooperation with the Fort Benning Land Management Branch (LMB) personnel. Woody productivity is being derived using data from the Forest Inventory procedure used by Fort Benning personnel. This procedure will provide watershed level and an installation-wide estimate of woody productivity and will support

both the installation and research group needs. During September 2001 forest inventory data were collected in the Delta 14 and 15 compartments that represent a portion of the area where ECMI monitoring is being conducted. These data will be used to estimate woody productivity in those compartments and results should be available on the repository during the 2QTR FY02. Data from additional compartments will be provided to the ECMI team as they are collected per Fort Benning's inventory schedule.

Milestones FY02

Three published technical reports and two technical notes that document the ECMI plan and methodologies	12/2001
Technical Report "Phase II ECMI Status and Progress"	09/2002
Straw Man White Paper "Installation-wide ECMI Methodology"	09/2002
Two published technical reports (physical monitoring and aquatic monitoring)	09/2002

Important Findings and Conclusions for FY01 (October 1, 2000 thru September 30, 2001)

Meteorology

The meteorology stations have performed very well since Summer 1999. Aside from recommended routine maintenance they require very little attention. A technical report is currently being prepared that describes the meteorology stations, the hydrology stations, and the ground water wells. The specifications for each and summarized data will be included. The report should be published during FY02.

Surface Water

The automated hydrological stations have been maintenance intensive. Aside from problems caused by the drought and low stream flows, sedimentation in and around the sensor packages has caused problems and the dissolved oxygen (DO) sensor did not perform to specifications. We are working with vendors to obtain more reliable DO sensors for the future. Currently only temperature, flow and level can be reliably monitored with automated stations and all water quality data are collected manually every two weeks. This procedure minimizes routine and non-routine maintenance time.

Ground Water

Five wells were drilled during FY 01 to monitor the shallow alluvial aquifers. The Bonham Creek site was dry with no indication of water down to 55 feet. The well site was within 100 feet of the main streambed. It is not known if this is a result of the current drought.

Aquatic

The following is a brief summary of initial findings of the four components of the aquatic monitoring component of the EMCI, 1) Rapid Bioassessment Protocol, 2) Macroinvertebrate Studies, 3) Periphyton, and 4) Benthic decomposition. A complete discussion of the rationale for the study, methods, and results of field and laboratory studies will be published in a technical report during FY02. The streams selected for monitoring are; Little Pine Knot, Wolf Creek, Randall Creek, Sally Branch, Bonham Creek, Uchee Creek, Cox Creek, Upatoi Creek, and Oswichee Creek.

Habitat conditions did not vary greatly among these streams with respect to macroinvertebrate support or leaf litter processing. Leaf litter loss rates were generally low between December 2000 and June 2001(ranging from near zero to approximately 15% in terms of total dry mass). Despite the largely organic nature of leaf litter, not much of the material was processed during the timeframe of monitoring thus far. Phytoplankton abundance appeared related to light penetration; more open canopies over wider streams supported the greatest phytoplankton growth. Natural leaf packs evaluated for macroinvertebrate community composition acted as "collectors" of stream organisms; they provided a relatively uniform habitat from which to collect invertebrates from different streams. Consequently, inter-site similarity among communities was perhaps slightly higher than would have been the case if substratum samples had been used. All creeks supported diverse benthos, and all but Cox and Randall creek were dominated by chironomids. However, all streams supported moderately dense and diverse faunal assemblages.

The range in habitat units at the 9 sites surveyed was from 101 to 162 units (Figure 1). Overall, the average score given to pool variability and pool substratum conditions (1.9 and 2.3, respectively) for all sites combined was extremely low (Figure 2). The values for Channel sinuosity and presence of cover for epiphytic invertebrates were both slightly less than 10 (Figure 2). The average value for all other habitat variables was higher than 15; the average value of variables that rated terrestrial vegetation and bank stability was 19 - 20. The value of all these streams for macroinvertebrates was negatively affected by the lack of pool/riffle sequences, and firm substratum composed of gravel, cobbles, or flat rocks. Although there was some site-to-site variation among all sites, none of these streams provide what could be considered optimum habitat for infaunal and epiphytic macroinvertebrates.

With respect to water quality, all sites were negatively affected by low pH and low specific conductance (Table 1). Aquatic insects, crustaceans, and mollusks all have exoskeletons that rely on calcium and magnesium, associated mainly with carbonate ions, for hardness. Although dissolved oxygen, water temperature, and water clarity were all optimal for aquatic life, the low pH, which is always associated with reduced levels of calcium and carbonates is sub-optimal for aquatic life.

Table 1. Summary of Water Quality Parameters Taken at Selected Streams in Ft. Benning, 5-6 Dec 00.

		Water Quality				
Stream	Waypoint	Air Temp °F	Water Temp °C	Conductance Micromho/cm2	DO Mg/l	pH
Pine Knot	2	45	5.5	37	11.4	5.3
Wolf	3	50	7.7	31	10.6	5.8
Randall	4	50	8.6	90	12.5	7.6
Sally Branch	5	55	4.5	52	12.7	3.8
Bonham	6	55	6.4	33	11.9	4.3
Uchee	7	50	8.8	83	12.2	6.0
Cox	8	35	3.4	99	11.6	6.3
Upatoi	9	45	6.0	30	12.0	6.0
Oswichee	10	50	6.1	44	11.8	4.2

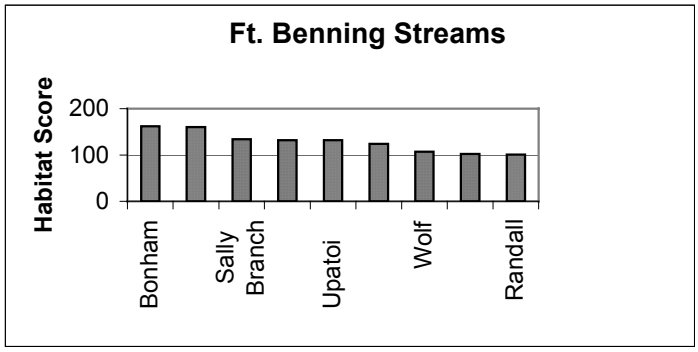

Figure 1. Habitat scores for nine stream monitoring sites.

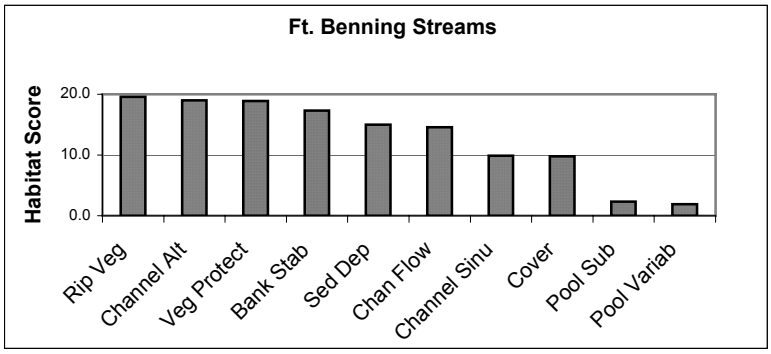

Figure 2. Habitat scores by variable type and across all monitoring sites.

Land Cover

Our intent was to provide a quality land cover map and procedure that best supports the needs of SEMP research groups and Fort Benning personnel. All land cover maps produced using an imagery classification process result in a generalization of the real land cover types. Therefore it was necessary to check the accuracy of the classification with ground truth data. The classification accuracy assessment was based on data from 187 Land Condition Trend Analysis (LCTA) plots allocated across Fort Benning based on a restricted random process. Based on LCTA methodology a general vegetation type is assigned to each LCTA plot that matches the classification used in developing the land cover map. The level of agreement or disagreement between the Landsat classification and the reference data indicated that the overall accuracy of the classification was 69.5 percent. The major forest-stand classes, hardwood and evergreen, displayed the highest level of agreement with the reference data, with user accuracies of 85 and 83 percent, respectively. Accuracies for evergreen planted, herbaceous, bare ground, and scrub/shrub were 70, 61, 61, and 5 percent respectively (Table 2). Data were not available to check the accuracy of the water, paved roads, and cantonment land cover (Bourne and Graves 2001).

There are several reasons why accuracy levels for certain cover types may be low and these will be investigated as the methods are improved. One likely problem is that the vegetation types assigned to the LCTA plots were based on monitoring data from 1996. Significant changes in vegetation cover is very likely over the last five years especially for the herbaceous and bare-ground, and scrub/shrub categories. Data based on a more current monitoring of the LCTA plots

or additional ground truth data collection has been planned to improve the accuracy assessment for future classifications.

Table 2. Error Matrix

Reference Data	Classified Data										
		Water	Evergreen/Planted	Evergreen	Hardwood	Scrub/Shrub	Herbaceous	Bare Ground	Paved Roads	Cantonment	Row Total	Producers Accuracy %
	Water	0	0	0	0	0	0	0	0	0	0	0
	Evergreen/Planted	0	14	1	2	1	2	0	0	0	20	70
	Evergreen	0	4	35	7	6	2	1	0	0	55	64
	Hardwood	0	1	2	53	4	6	1	0	0	69	77
	Scrub/Shrub	0	1	0	0	1	0	1	0	0	3	33
	Herbaceous	0	0	2	0	6	19	2	0	0	29	66
	Bare Ground	0	0	0	0	1	2	8	0	0	11	73
	Paved Roads	0	0	0	0	0	0	0	0	0	0	0
	Cantonment	0	0	0	0	0	0	0	0	0	0	0
	Column Total	0	20	42	62	19	31	13	0	0	87	
	Users Accuracy %	0.0	70	83	85	5	61	61	0	0		
Overall Accuracy = 69.5%												

User's Accuracy - The percentage of map-derived samples that are correctly mapped.
Producer's Accuracy - The percentage of field-derived samples that are correctly mapped.

Land Cover Pattern Analysis

The following graphics represent the initial findings of an analysis of landscape pattern metrics using the FRAGSTATS software. Metrics based on core area represent both landscape composition and landscape configuration and are usually thought of as being a better predictor of habitat quality than metrics based on patch size alone. Plots of selected metrics are shown in Figures 3-5, and provide a general representation of landscape pattern on Fort Benning.

Further work is required to complete specific landscape pattern analyses, and these initial numbers should be used with caution. For example, the cell size of the source imagery (28.5m) resulted in the presence of many small polygons in the land cover map. In addition, a cloud obscured almost 1 percent of the total study area, and resulted in a "no data" polygons that affected the analyses. Plans are to use ancillary data sources (such as digital orthophoto photography) to fill in these areas of missing data. Other adjustments to the classes will also be done (breaking out forest classes by forest type, for example). We will continue to work with Virginia Dale and Lisa Olsen to develop the best procedures and techniques for producing landscape cover products.

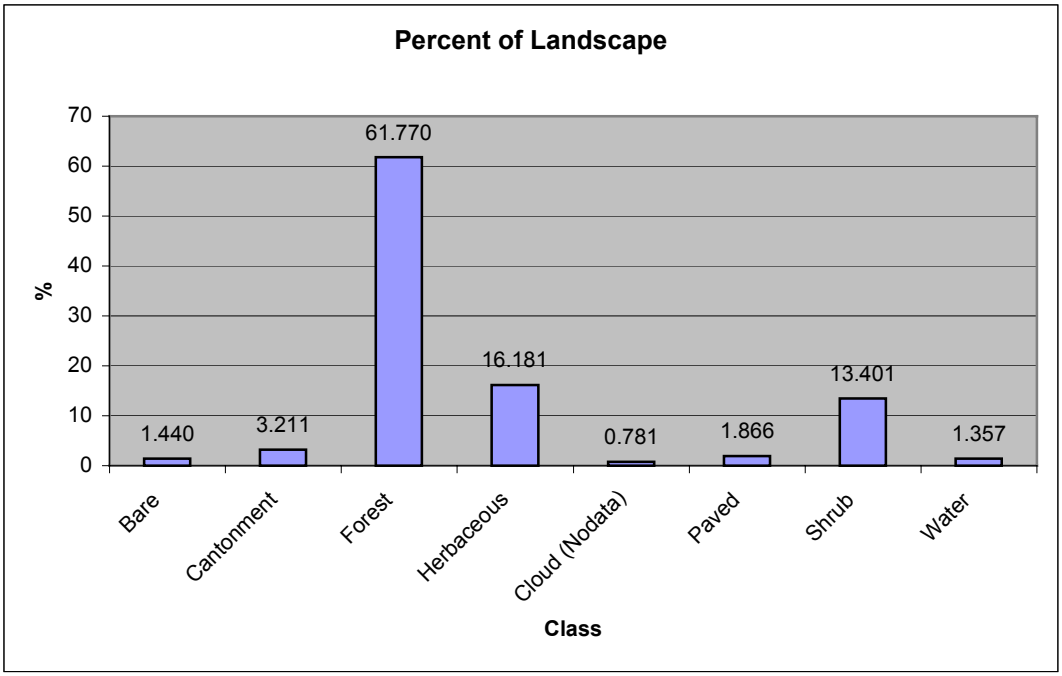

Figure 3. Land cover as percent of landscape

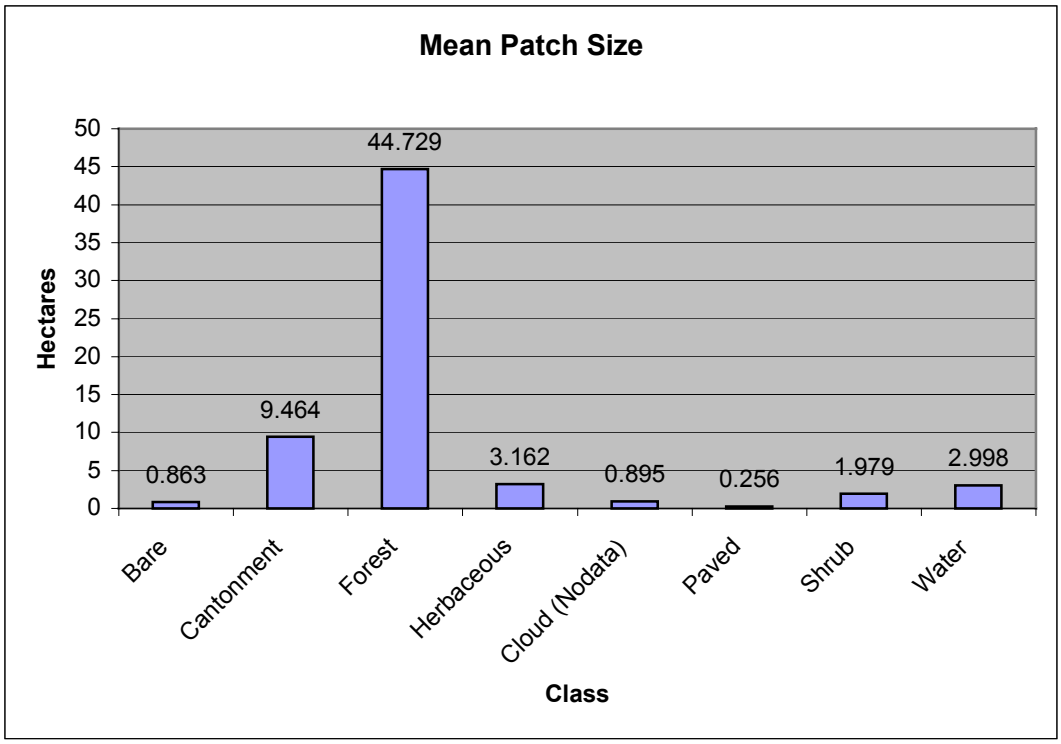

Figure 4. Mean patch size of land cover types

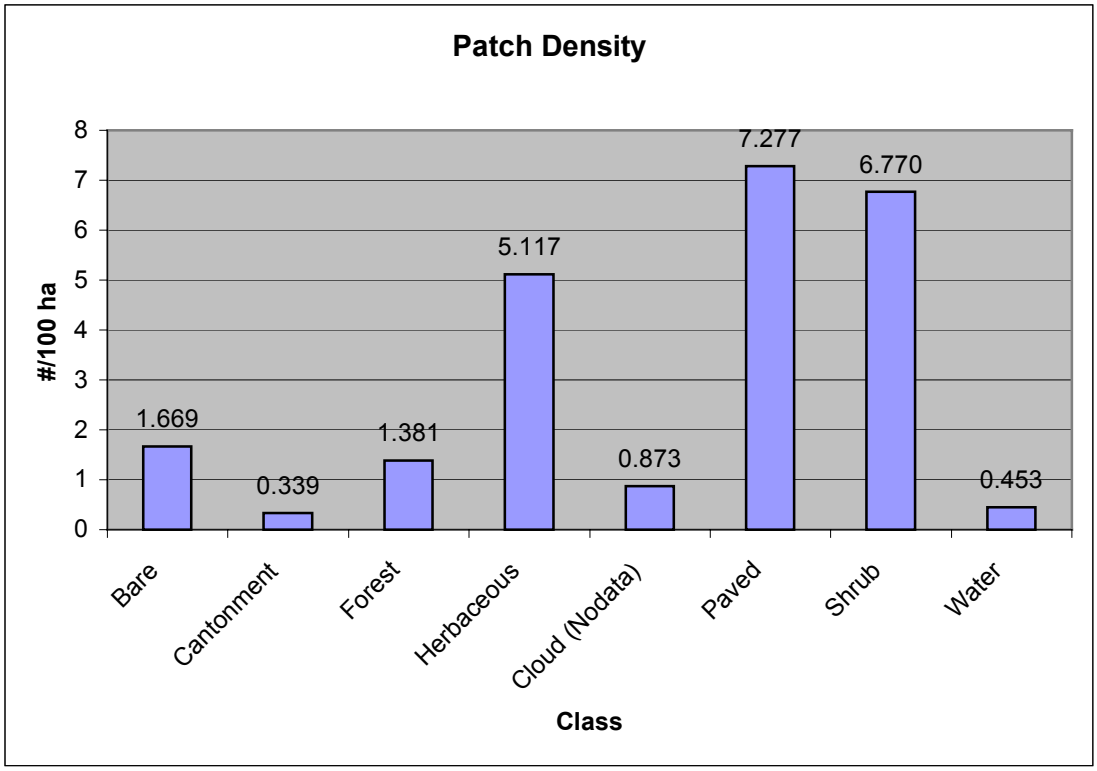

Figure 5. Patch density by land cover type

Erosion and Deposition

The purpose of the erosion/deposition characterization and monitoring design is to provide the necessary data to accurately estimate erosion and deposition dynamics at the watershed and installation scales, over time on Fort Benning, Georgia. These data will support the SEMP research efforts and the installation land management branch.

Currently, there are 26 erosion/deposition monitoring sites (20 X 20 meters) located on Fort Benning via a restricted random process. Ten sites are located in Sally Branch and ten are located in Bonham Creek watersheds. An additional six sites are co-located with existing Land Condition Trend Analysis (LCTA) sites to represent the installation scale. These sites were characterized by micro-topographic surveys during Spring 2001 and were re-surveyed (monitored) in late September and early October of 2001. They will be monitored every year thereafter.

Prior to surveying the sites an accurate X, Y, Z control network with three control points was set up for Fort Benning. The control points were then used as base stations for real-time kinematic (RTK) GPS surveys to accurately survey the micro-topography of each erosion-monitoring site.

Available data from these surveys will be the raw micro-topography survey points for the entire 20 X 20 meter sites, elevation profiles for the 0, 5, 10, 15, and 20-meter location on each site (Figure 6.), and a triangulated irregular network (TIN) derived from the point shape file in ArcMap using the 3D Analyst Software extension (Figure 7.). The RTK GPS survey data used to develop the control points are available for anyone needing accurate X, Y, and Z coordinates for Fort Benning.

A more complete description of the methods and data can be found in “Hahn, D. H., Graves, M. R., and Price, D. L. (2001). S-Tracker survey of sites for long-term erosion/deposition monitoring, ERDC/EL TR-01-18, U.S. Army Engineer Research and Development Center, Vicksburg, MS., that can be located and downloaded from the ERDC Vicksburg web site.

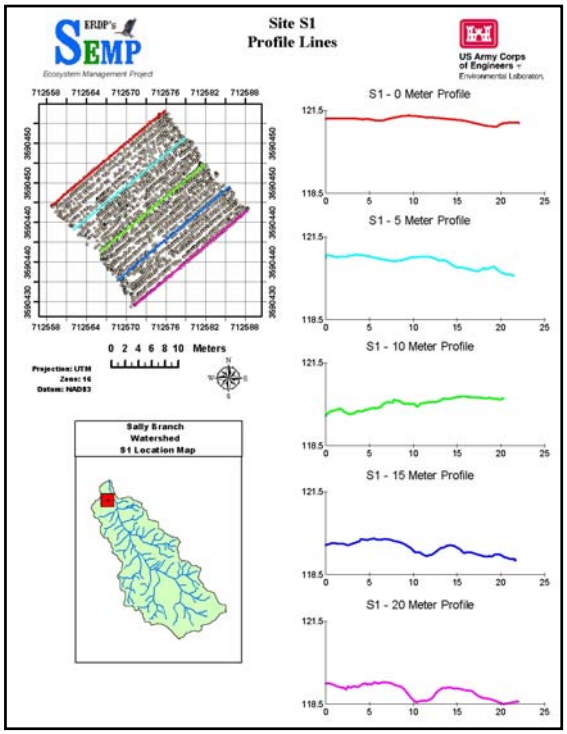

Figure 6. Survey Points and Profile Lines

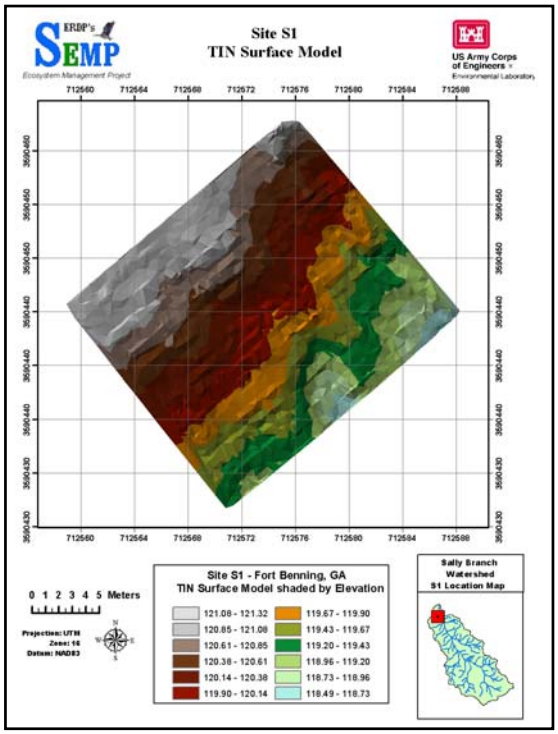

Figure 7. TIN Surface Model

Woody Productivity

Fort Benning Forestry staff are scheduled to begin the implementation of the revised Forest Inventory protocol about December 2001. In cooperation with the ECMI team the staff have agreed to implement the revised inventory protocol at the species level for at least the major woody species. This is a direct effort to design the ECMI to meet both research and installation needs, be easily incorporated into the installations business process, and provide monitoring information at multiple spatial scales. We have also enlisted the help of Dr. George Gertner of the University of Illinois to provide expert consultation to Fort Benning and ECMI staff regarding additional improvements to the protocol. Dr. Gertner will visit and consult with the staff during December 2001.

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